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THE PERMIAN LIFE OF TEXAS.

By CHARLES H. STERNBERG, Lawrence, Kan.

Read before the Academy, at Iola, December 31, 1901.

I CONDUCTED an expedition into the valley of the Big Wichita, Baylor county, Texas, for the Paleontological Museum of Munich, Bavaria. I began work on the 14th of June, 1901, and continued four months. I was employed by the famous Doctor von Zittel, the early teacher of the deceased Cope and many other noted American paleontologists. It was pleasant to receive these words of praise from such a noble source: "Your collections from Kansas and Texas in the Munich Museum will always be, as I wrote you, an everlasting memorial to the name of Charles Sternberg." I labored this season, assisted by my son George, under trying conditions, the heat often running the mercury up to 113° in the shade, and, when reflected from the brilliantly colored rocks, it was very severe on the eyes. The whole Wichita valley this year is almost a desert. The few cattle, scattered over thousands of acres, are poorer than I have seen them in midwinter during former years. There are no wells or springs in the Red Beds. Spasmodic showers are partly retained in natural or artificial tanks. I had to haul my camp water from six to eighteen miles, as well as hay and grain for my team. By constant effort, under the difficulties that beset me, I was able to add twenty distinct forms to the Permian fauna of the Munich Museum and to science. They will be carefully studied and described.

No work, I believe, has been done on these remote ancestors of living animals since Cope died, except in Munich, where, in 1899, Doctor Broili, Doctor von Zittel's assistant, wrote a valuable paper on Cope's great salamander, *Eryops megacephalus*, as the result of his study of the material I collected for them in 1895. Last August, Doctor Broili came from Bavaria to visit my camp, and spent two weeks with me in the field, taking photographs and notes of the formation. He was delighted with the results of my work, assuring me that the collection had far greater scientific value than the one I made their museum in 1895. I think quite a number of new species are present, as well as many described by Professor Cope. One, his *Diplocaulus magnicornis*, was quite common in certain localities.

I found in the roots of the grass, and along a slide, ten casts of skulls I thought worth saving, with fragments of many others scattered around. Every particle of bone had disappeared. I got several better specimens than the type. The vertebral column and limbs

were present in several specimens. I suppose this unique amphibian was an ancient frog. The skull is very much compressed vertically; the mandibles are usually locked together with the maxillæ; at the chin the jaws are only about half an inch thick, while the horns are an inch and a half. I found several skulls that measured over a foot from the end of the premaxilla to the distal point of the horns. The whole skull appears as a comical imitation of the man in the moon when he is half full. The very beautiful sculpture on all the outer bones of the skull is remarkable. The vertebræ have twin spines on each side of the centra. I think, when alive, this frog must have been six feet long. In another species I discovered, of the same genus, the skull was much narrower behind. It was beautifully cleaned by long erosion, and so perfectly preserved that it was not difficult to believe it was a recent specimen.

As a rule, all the fossils of this region are covered with a thin siliceous matrix that is difficult to remove; when exposed to the weather for a long time this is sometimes worn off. This region was the home of Cope's great salamander, *Eryops megacephalus*, which ought to mean flat-headed. When we compare our living American salamanders, that rarely exceed eight inches, with this grandfather of all the mud puppies, we are struck with the enormous proportions reached by *Eryops* during the Permian. I found an absolutely perfect skull this year that was about twenty inches long, including the bones that support the tongue. It is covered with a thin, red, siliceous matrix, which I hope can be removed. All the outer bones of the skull are beautifully sculptured. The bones that support the broad, flat quadrate are projected well back of the base of the skull. The lower jaws extend still further back and are more powerful than those of an ox. A single row of large and small teeth, conical in shape, occupy the jaws, while the palatines carry six sets of two powerful teeth each, placed closely together, three sets on each side of the roof of the mouth. The skull is vertically compressed, but, unlike *Diplocaulus*, the eyes are placed well back in the face. The occipital condyles are shallow, saucer-like pits. The creature was about ten feet long.

I found a nearly complete skeleton of this huge animal for Professor Cope in 1896, under peculiar circumstances. It lay at right angles to a large cattle trail over which thousands of Texas cattle had made their weary pilgrimage to Kansas and the North, and the constant wear of countless feet had worn off the flint-like matrix and exposed the completely petrified bones, while on the ridges they were not exposed at all, except in cross-section caused by breaks in the rock. The vertebræ are of lowly type. The centrum is composed of three distinct bones, the central or *plurocentrum*, and the two lateral ones or *hypo-*

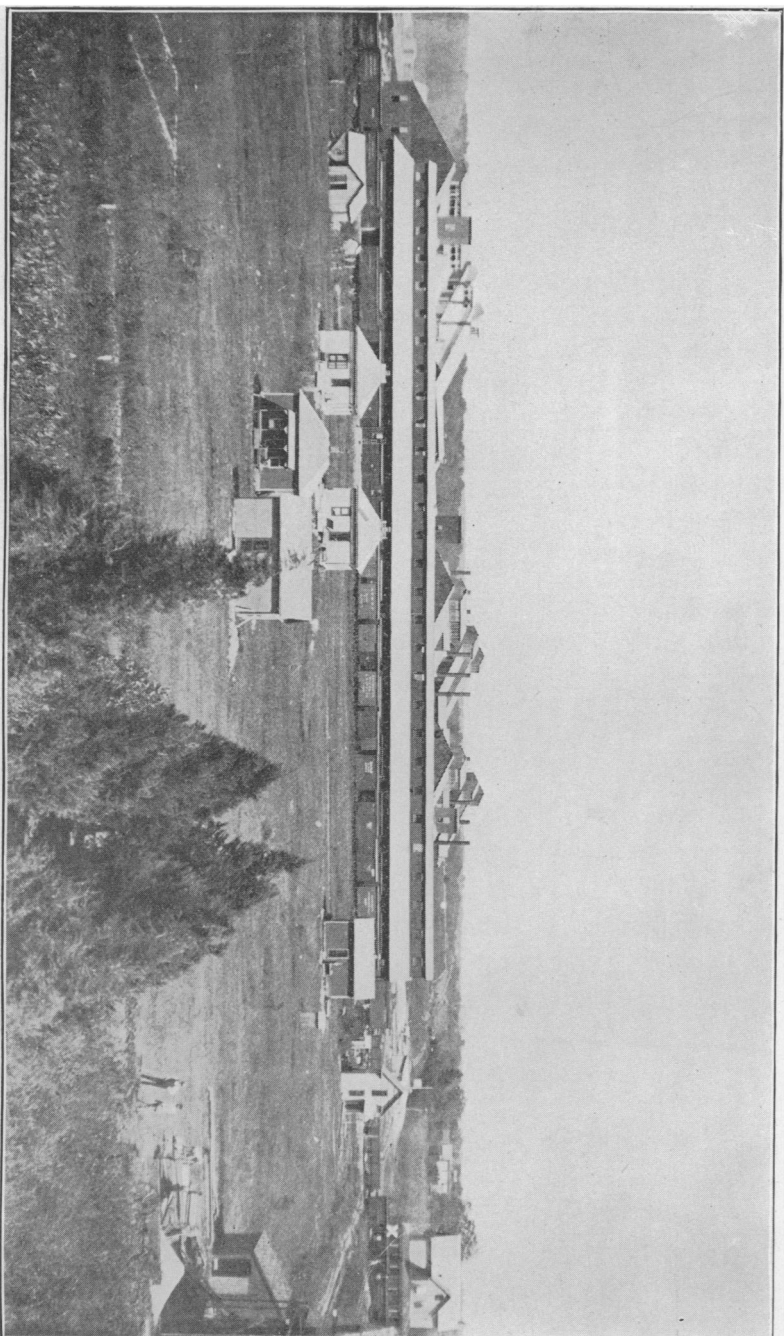
centra. The dorsal spine with its processes attached are in one piece.

That same year (1896) I was so fortunate as to find a batrachian with a carapace—one of those discoveries of a lifetime that connects great orders. Professor Cope believed this to be the parent stem from which the family of turtles sprang at a later stage in the history of life.

My son and myself discovered three bone-beds full of minute forms, several of which are, I believe, new in science. I look forward with great interest to their description by the Munich Museum. They range in size from less than a quarter of an inch to over an inch in length. I collected over twenty skulls, and many more or less perfect. Quite a number had vertebræ attached. I collected thousands of bones from all parts of the the skeletons. In one case a complete skull one-fourth of an inch in length had connected with it nearly the complete column with ribs attached, coiled upon itself, and bedded with many bones of other species in a red, siliceous matrix. So perfectly were they weathered out, that they lay in bas-relief as white as snow, and as perfect as if it died a month ago. A single row of minute teeth, like the points of cambric needles, filled the jaws. It seemed to me that this little fellow, not over six inches in length, must have made a snug bed in the mud and lay down to hibernate, but never awakened; millions of years later I found him ready to do his share, by adding one more fact to human knowledge—one more link to the endless chain of life that nature has produced so abundantly on this old world of ours. I dare not even guess at the family to which it belongs. The bones of the skull are perfectly preserved, quite smooth, and show the sutures distinctly; there is no distortion. Some red rock attached below seems absolutely necessary to convince the mind it is not a thing of yesterday.

Another, broad and flat, a little like *Diplocaulus*, with eyes well forward. It is an inch in length, with delicate tracery upon the bones, single rows of minute teeth in the jaws. Some were compressed laterally, the delicate little quadrates connecting the mandibles with the skull at an angle of forty-five degrees. In this form the orbits are placed well back in the face. Another extremely beautiful skull had the bones marked by small dentations and elevations; was much compressed vertically; there were small teeth in the front part of the mouth only.

I should not neglect, in this connection, the enormous *Dimetrodon* of Cope, a reptile of large proportions and huge dorsal spines. Some of these spines were over three feet long, with a pair of lateral spines at the base, which then alternate to the apex, smooth and conical in



Iola Portland Cement Mill, 1900.

shape, slightly recurved, with round, indented knobs at the ends. The first pair are about three inches long, and gradually decrease in size as they ascend. I call this animal "the ladder-spined reptile." I am told that Professor Cope believed these spines served as masts and yard-arms, from which were stretched membranous sails which enabled them to catch the breeze and tack along the surface of the ocean. Possibly, as the vertebræ are small and the spines extremely slender, these lateral processes gave stability, when securely bound by strong ligaments to the flesh on the column, preventing dislocation. I have found many fine specimens of this remarkable reptile. One found this year represented parts of the upper jaws. A huge, massive bone projects beyond and below the huge tusks in the lower jaws, bent in a curve, presenting a unique appearance, for what purpose I can hardly guess, unless to give rest to the head while sleeping. But time would fail me to tell even in this cursory manner of all the strange life preserved for us of these ancient mariners who lived in the water or along the swampy shores of the Permian ocean. How those ancient frogs must have tortured the ear of night on a warm summer evening!

I must now turn a short time to the rock formations, of which there are two distinct ones in the valley of the Big Wichita, in Texas, which give characters to the surface of the country, as different from each other as if separated by hundreds of miles. I visited one locality on Pony creek where the Red Beds lie on top of the Gray Beds conformably. Looking to the west, a vast panorama of crumbling and denuded bluffs, narrow valleys, beetling crags, desolate and forlorn, with the universal red color dominating everything, except here and there relieved by the green of stunted mesquites or patches of verdure, was spread out before me. To the east lay the narrow valley of Pony creek, with the same topography so familiar to the residents of eastern Kansas—a ledge of gray sandstone, forming a narrow escarpment on either side, and following the trend of the hills around the ravines; grass coming down in gentle swells to meet it, or running up from the bottom lands below. The greatest thickness of this sandstone, as I observed it, was near my camp in the creek bottom where I had pitched it, eight miles north of Seymour, the county-seat of Baylor county. This was at the head of a narrow gulch that had cut through it. I made a section and sent samples of the rock to Munich. As I observed it under peculiar circumstances, it solved another interesting problem—the water-supply of the Red Beds. I discovered why the water that falls where these beds are only exposed runs off soon after a shower, except when caught in natural or artificial tanks. No wells

or springs are ever found. In the Gray Beds, however, there are always springs and streams of running water.

In September, 1901, the heaviest rain since May fell in torrents for an hour and a half. Water lay everywhere on the surface of the ground, but soon disappeared. My son had discovered a locality rich in fossil invertebrates, consisting chiefly of casts of coiled and straight, nautilus-like shells, across the creek, and shortly after the downpour I went over there to my work, but had not been engaged long before George shouted to me that if I did not want to swim I had better cross. His advice I followed so hastily that I left my tools behind. Instantly a raging, boiling flood of water covered the rocks in the bed of the creek over which I had just crossed dry shod, rapidly rose to eight feet, and threatened to submerge my camp. Looking for good ground on my side of the creek (the west), I found the gulch before referred to. There was first a level floor, formed by the first stratum of the Gray Beds, extending west 500 yards to a ledge of red sandstone eight feet thick, the floor covered with the debris washed from the Red Beds. To my astonishment, although the surface was dry, a flood of water was rushing out from under the upper deposits, and tumbling in a miniature waterfall over the gray ledge (nearly five feet thick) into the ravine below. The upper sandstone layer is composed of very fine-grained sand that seems to have been ground into an impalpable powder by the beating of the waves. It is very compact and heavy, breaking on exposure into rectangular blocks so perfect in shape that they can be used for building purposes without the use of the hammer and chisel. This stratum is eight inches thick, and is free from fossils. I believe it contains some lime. The second stratum breaks into large blocks of many tons weight, contains a few casts of invertebrate fossils, is coarser grained than No. 1, and about twenty inches thick. No. 3 is of the same general character as the other layers, twelve inches thick, and literally packed full of the casts of straight and coiled shells related to our living nautilus, and they are mingled in great confusion. I believe some of the coiled shells were a foot in diameter. This stratum is not as compact as the others, and seems to contain more lime. No. 4 is a very solid gray sandstone, eight inches thick, its upper surface crossed at various angles by elevated rounded ridges of harder material than the rest.

From these observations, I conclude that the pervious nature of the Red Beds, which in the valley of the Big Wichita are about 300 feet thick, allows the water that falls upon them to rapidly percolate through until it reaches the impenetrable gray sandstone; then it runs off at whatever angle the rock may be tilted.